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Diversity of predatory arthropods in Bt and non-Bt cotton fields of Nalgonda district, Telangana state, India

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Abstract

The study was conducted to investigate diversity of predatory arthropods (Predatory insects and Spiders) in Bt cotton and non-Bt cotton fields during July 2018 to January 2019 at farmers field of Palem Village, Nalgonda District, T.S, India. A total 4768 individual arthropods on Bt cotton, 5232 individual arthropods on non-Bt cotton fields were collected with the help of sweep net and hand picking. The predatory arthropods were identified with the help of Guide on cotton pests and predators, Regional Agricultural Research Station PJTSAU Warangal and literature. Eleven predatory insects and two spiders in Bt cotton and thirteen predatory insects and three spiders in non-Bt cotton were recorded. The results indicated that minor differences found between the Bt and non-Bt cotton fields. Our findings conclude that Bt cotton may affect predatory arthropods indirectly through removal of eggs, larvae and pupa of insect pests that serve as food for predatory arthropods. Various diversity indices were measured.

Keywords: Bt cotton, non-Bt cotton, predatory arthropods, ecological indexes and seasonal abundance

Introduction

Cotton, *Gossypium hirsutum* L., belonging to Family Malvaceae; Order Malvales is one of the most important commercial crop, playing a key role in economic, political and social affairs of the world. It is commonly known as “White gold” and unanimously designated as “King of fibres”. Cotton plant is sun loving and requires 180-days with temperature 28 to 35°C. The crop requires approximately 30 inches of rain or irrigation ^[1]. It is useful in producing five basic products i.e. lint, oil, seed meal, hulls and linters. India ranks first in the world having 11.8 million hectares area under Bt cotton, followed by China and USA ^[2]. It also provides 65% raw material to textile industry and contributed 1/3rd of total foreign exchange earning of India ^[3]. Cotton plants are very sensitive in nature and damaged at its different phenological stages by insect pests, which attack the roots, shoots, tender leaves and fruiting bodies. Cotton crop is susceptible to attack of 96 insect and mite pests ^[4]. Major pests of cotton are American bollworm, spotted bollworm, pink bollworm and sucking pests like leafhoppers, whitefly, thrips and aphids. However, bollworms have been tackled by introducing Bt cotton. Biological control has considered a reliable and long term solution of the insect pest problems due to self-perpetuating nature and environment friendly tactic ^[5]. Predatory arthropods growing widely in fields are one of the natural sources of pest management. When arthropod predators are abundant in cotton field higher pest levels can be tolerated for longer periods without pesticide use that means there is a saving of pest control cost. Predatory fauna including spiders play an important role crop pest management ^[6]. Cotton plant hosts the rich diversity of insect predators and spiders that attack on different life stages of insect pests (egg, larval, pupal and adult stages) and provide natural balance.

Predators are essential biological control agents ^[7, 8]. Predators such as *Brumoides suturalis*, *Cheilomenes sexmaculata* and *Coccinella transversalis* suppress the population of various cotton insect pests especially *Helicoverpa armigera*, *Spodoptera exigua*, *S. litura* and *Aphis* sp. Coccinellid predators (*C.transversalis*, *Ch. Sexmaculata*) are the important natural enemies of aphid and keep the aphid population below the economic threshold ^[9].

Spiders are also essential biological control agents ^[10, 11]. Spiders such as *Neoscona theisi*, *Peucea viridans* and *Rhene* sp suppress the population of various cotton insect pests especially *Amrasca biguttula biguttula*, *Chlorotettix* sp, *Empoasca* sp, *Sogatella furcifera* and *Flatormenis* sp.

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Main objective of the study to investigate diversity of predatory arthropods (Predatory insects and Spiders) in Bt cotton and non-Bt cotton fields.

Materials and Methods

The study was carried out at farmer's fields of Bt cotton (SRCH-639 BG II) and non-Bt cotton during kharif season in semi-arid tropical region of Palem village, Nalgonda District, Telangana State. It is located between 17° 13' 49''N and 79° 28' 04'' E. Sample was done every month from July 2018 to January 2019, in the morning because most of insects become active when temperature is about 25°C to 30°C [12]. Sweep net and hand picking method was used for the collection of predatory arthropods (predatory insects and spiders) on Bt and non-Bt cotton plants [13]. For predatory arthropod investigation five plots each having area 5m x 5m was selected in both Bt and non-Bt cotton fields. Whole plants were observed visually for the number of immature and mature population of insect pests and predatory arthropods. The whole plant was observed from bottom to top and both sides (Upper and lower side) of the plant leaves. The predatory arthropod population was carefully counted with help of 5x magnifier lens and collected by hand picking. Each preserved in 75% alcohol for identification. Predatory arthropod species were identified with the help of Guide on cotton pests and predators [14], Regional Agricultural Research Station PJTSAU Warangal and Literature.

We calculated Diversity indices of predatory arthropod species i.e. Species diversity (Shannon-Wiener Index), Species richness (Margalefs Index) Species evenness (Pielou Evenness Index).

1. Species diversity [Shannon-Wiener index (H)]

$$H = -\sum P_i \log P_i$$

Where, H = Shannon – Weiner index, \sum = Sum, $P_i = n_i / N$, n_i = Number of individuals of each species in the sample, N = Total number of individuals of all species in the sample.

2. Species evenness [Pielou Evenness Index (J)]

$$J = H / H_{\max}$$

Where, J = Evenness index, H= Shannon – Weiner index, $H_{\max} = \log S$, S = number of species.

3. Species richness [Margalef's Index(D)]

$$D = \frac{S-1}{\log N}$$

Where, D= Species richness, S= total number of species, N= total number of individuals.

Results

During the study period, from July-2018 to January-2019, a total of 4768 individual arthropods from Bt cotton, 5232 individual arthropods from non-Bt cotton fields were collected by sweep net and hand picking. More arthropod individuals collected in non-Bt cotton compared with Bt cotton. Minor difference in the predatory insects and spiders occurred between Bt and non-Bt cotton fields. Eleven predatory insects and two spiders in Bt cotton and thirteen predatory insects and three spiders in non-Bt cotton were recorded during the cropping season and which belonged to seven different orders, fourteen different families, out of them seven orders from Bt cotton and six orders from non-Bt cotton, eleven families from Bt cotton, thirteen families from non-Bt cotton. The number orders did not differ significantly, however number of families differ significantly between Bt and non-Bt cotton fields.

The Coleoptera order represented by the high number of species (4-Species) followed by the Diptera (3-Species), Hymenoptera(1-Species), Montodea (1-Species) Neuroptera (1-Species) and Odonata (1-Species) on Bt cotton fields and Coleoptera order represented by high number of species (5-Species) followed by the Diptera (3-Species), Hymenoptera (2-Species), Odonata (2-Species) and Montodea (1-Species) on non-Bt cotton fields. The Araneae order represented by the two species on Bt cotton and three species on non-Bt cotton fields.

The predatory insects *Brumoides suturalis* (Three-stripped lady birdbeetle), *Cheilomenes sexmaculata* (Six-spotted zigzag ladybird beetle), *Coccinella transversalis* (Transverse ladybird beetle), *Paederus* sp (Rove beetle), *Cochliomyia* sp (Blowfly), *Musca* sp (Housefly), *Scanthophaga* sp (Dungfly), *Componotus* sp (Black ant), *Mantis religiosa* (Praying mantis) and *Libellula* sp (Skimmer dragonfly) were observed in both Bt and non-Bt cotton fields. The predatory insect *Chrysopa* sp (Green lacewing neuropteran) was observed in Bt cotton only and the predatory insects *Propylea dessecta* (Spotless ladybird beetle), *Vespula* sp (Wasp) and *Calopteryx splendens* (Banded damselfly) were observed in non-Bt cotton fields only.

The spiders *Neoscona theisi* (Spotted orb-weaver/barn spider) and *Peucetia viridans* (Green lynx spider) were observed in both Bt and non-Bt cotton fields. The spider *Rhene* sp (Jumping spider) was observed in non-Bt cotton field only (Table. 1).

Table 1: Diversity of Predatory arthropods in Bt & Non-Bt cotton fields-2018-2019

Order	Family	Species		Common name
		Bt cotton	non-Bt cotton	
Coleoptera	Coccinellidae	<i>Brumoides suturalis</i> (Fabricius)	<i>Brumoides suturalis</i> (Fabricius)	Three-stripped lady birdbeetle
		<i>Cheilomenes sexmaculata</i> (Fabricius)	<i>Cheilomenes sexmaculata</i> (Fabricius)	Six-spotted zigzag ladybird beetle
		<i>Coccinella transversalis</i> (Fabricius)	<i>Coccinella transversalis</i> (Fabricius)	Transverse ladybird beetle
		-	<i>Propylea dessecta</i> (Mulsant)	Spotless ladybird beetle
	Staphylinidae	<i>Paederus</i> sp	<i>Paederus</i> sp	Rove beetle
Diptera	Calliphoridae	<i>Cochliomyia</i> sp	<i>Cochliomyia</i> sp	Blowfly
	Muscidae	<i>Musca</i> sp	<i>Musca</i> sp	Housefly
	Scanthophagidae	<i>Scanthophaga</i> sp	<i>Scanthophaga</i> sp	Dungfly
Hymenoptera	Formicidae	<i>Componotus</i> sp	<i>Componotus</i> sp	Black ant
	Vespidae	-	<i>Vespula</i> sp	Wasp
Mantodea	Mantidae	<i>Mantis religiosa</i> (Linnaeus)	<i>Mantis religiosa</i> (Linnaeus)	Praying mantis
Neuroptera	Chrysopidae	<i>Chrysopa</i> sp	-	Green lacewing neuropteran

Odonata	Calopterygidae	-	<i>Calopteryx splendens</i> (Harris)	Banded demoiselle damselfly
	Libellulidae	<i>Libellula</i> sp	<i>Libellula</i> sp	Skimmer dragonfly
Araneae	Araneidae	<i>Neoscona theisi</i> (Walckenaer)	<i>Neoscona theisi</i> (Walckenaer)	Spotted orb-weaver/barn spider
	Oxyopidae	<i>Peucetia viridans</i> (Hentz)	<i>Peucetia viridans</i> (Hentz)	Green lynx spider
	Salticidae	-	<i>Rhene</i> sp	Jumping spider

Table 2: Ecological Indexes for Predatory arthropods in Bt & Non-Bt cotton fields

	H-Values		Evenness		Richness	
	Bt	non-Bt	Bt	non-Bt	Bt	non-Bt
Coleoptera	1.289	1.468	0.93	0.912	0.716	0.846
Diptera	1.028	1.064	0.935	0.969	0.588	0.6
Hymenoptera	0	0.433	-	0.625	0	0.289
Mantodea	0	0	-	-	0	0
Neuroptera	0	-	-	-	0	-
Odonata	0	0.617	-	0.89	0	0.39
Araneae	0.517	0.826	0.746	0.752	0.286	0.546

Three characteristics were calculated i.e. 1. Species diversity (Shannon-Wiener Index), 2. Species evenness (Pielou Evenness Index) and 3. Species richness (Margalefs Index) for analysis of community structure of predatory arthropods (Table. 2).

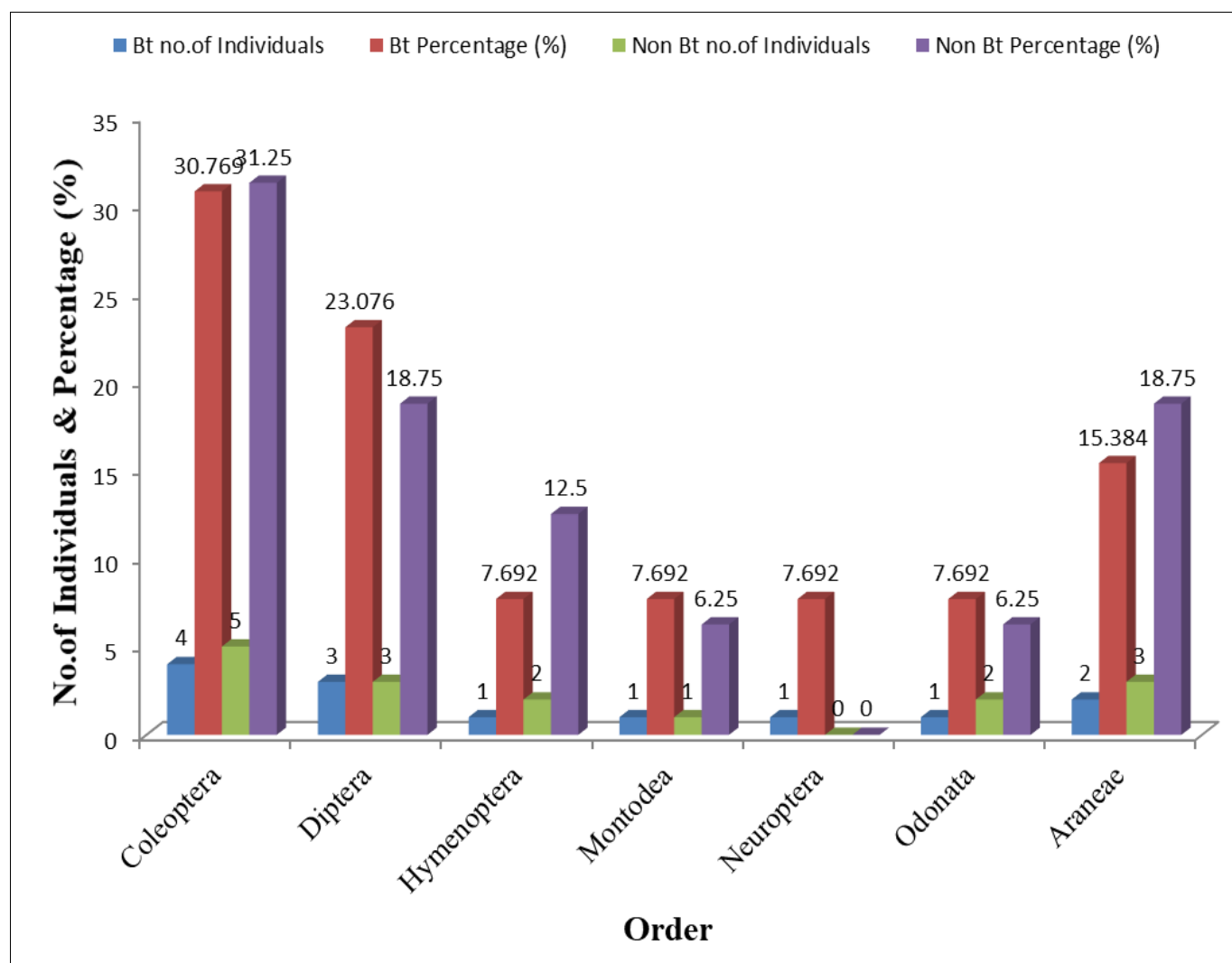
Ecological indexes showed that species composition of Predatory arthropods in each cotton ecosystem show constating patrons.

The H-values of Hymenoptera, Montodea, Neuroptera, Odonata and Araneae under 1.0 indicate that the habitate

structure not suitable. In case of Coleoptera , Diptera H-values above 1.0 indicate that Bt cotton fields are stable for them. In case of non-Bt cotton H-values are between 1.064 and 1.468 indicate that the structure of habitate is stable and suitable balanced for them.

Evenness values are in Bt and non-Bt cotton are closer to 1.0 indicate that the individuals are distributed equally.

Richness values are in Bt and non-Bt cotton are under 0.5 it indicate that the individuals are low, closer to 1.0 indicate that the individuals are more.

**Fig 1:** Percentage of different Predatory arthropods in Bt & Non-Bt cotton fields

Over all 29 individual predatory arthropods were recorded in one cropping season in both Bt and non-Bt cotton fields. A eleven predatory insect individuals and two spiders in Bt cotton and thirteen predatory insect individuals and three spiders in non-Bt cotton fields were recorded (Fig. 1)

Order Coleoptera is dominated with 30.769 % followed by Diptera with 23.076%, Hymenoptera with 7.692 %, Montodea

with 7.692%, Neuroptera with 7.692 % and Odonata with 7.692% in Bt cotton field.

Order Coleoptera is dominated with 31.25 % followed by Diptera with 18.75%, Hymenoptera with 12.5 % and Montodea with 6.25% in non-Bt cotton field.

Order Araneae represented by 15.384 % in Bt cotton field and 18.75 % in non-Bt cotton field (Fig. 1).

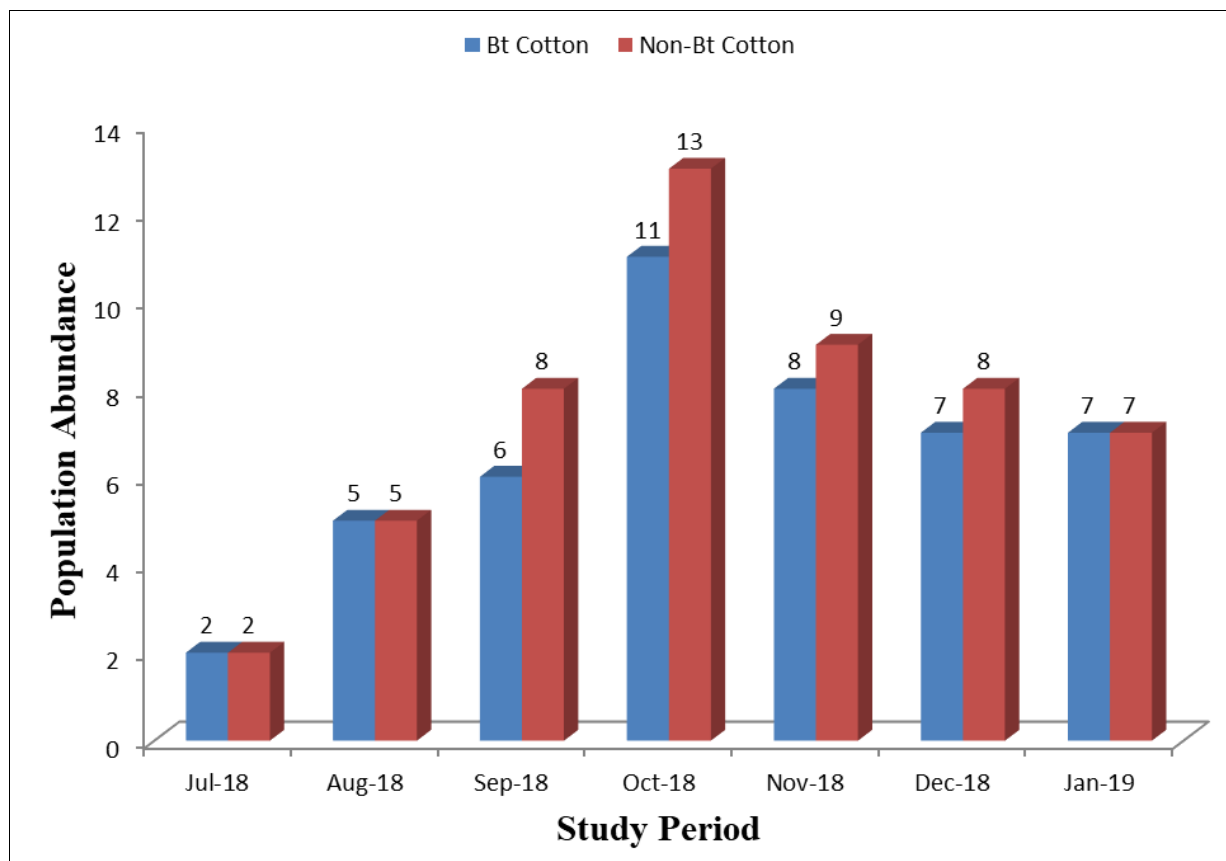


Fig 2: Seasonal abundance of total Predatory arthropods in Bt & Non-Bt cotton fields

The seasonal abundance of predatory arthropods were recorded in Bt and non-Bt cotton fields. Seasonal abundance was lower in both crops in month of July-2018, gradually increased from July-2018 to October-2018, thereafter decreased from November-2018 to January-2019. We noticed that the low differences in abundance of predatory arthropods between Bt and non-Bt cotton fields (Fig. 2).

Discussion

Our results indicate that minor differences in the predatory arthropod communities occurred between Bt and non-Bt cotton fields. The number of arthropod predators found in this study was obviously lower in Bt cotton in comparison to non-Bt cotton fields [15]. Many previous studies on predatory arthropod diversity and abundance between Bt and non-Bt cotton which is similar to our comparison between Bt and non-Bt cotton [16, 17]. Contrary to our results [18] noted no adverse impact of Bt toxin on diversity of arthropods. [19] reported higher population of predatory arthropods in non-Bt cotton as compared to Bt cotton. [20] reported decreased diversity of predators in Bt crops as compared to non-Bt crops. Our results demonstrated that non-Bt cotton plots had more predatory insects and spiders than Bt cotton plots and slightly higher abundance on non-Bt cotton than Bt cotton fields. Similar to our investigation [21] reported that the predatory insects and spiders are more number on non-Bt

cotton compared with Bt cotton fields. [22] reported typically minor effects of Bt toxin on beneficial insects.

Conclusions

The result of the study has shown that lower reduction in number of predatory arthropods. Our findings conclude that Bt cotton may affect predatory arthropods indirectly through removal of eggs, larvae and pupa of insect pests that serve as food for predatory arthropods.

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